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Fog Density Indicator

by

J. R. Bibby
(Meteorological Office)

AIR MINISTRY
METEOROLOGICAL RESEARCH COMMITTEE

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Historical

Development started in 1950 with a request by the Ministry of Civil Aviation for a method of measuring the depth of a fog layer, and preferably also the variation of visibility with height, up to at least 500 ft. The most practicable method appeared to be to measure the scattering of light in the air by an instrument carried on a tethered balloon.

At first it was hoped to make an instrument which could be used in daylight as well as darkness. A model was made, using a series of baffles to exclude daylight, but it proved too heavy for the radio-sonde balloons it was proposed to use. Also it appeared that there would always be doubt whether the air inside was representative of that outside. A much simplified instrument was therefore designed for use in darkness only. It weighs (without batteries) about 750 grams.

2. Description

A simplified drawing of the instrument is shown in Fig. 1. A "sandwich" is formed from two sheets of perspex $9\frac{1}{2}$ in. x $7\frac{1}{2}$ in. x $1/10$ in. thick, each with a rectangular hole $3\frac{1}{2}$ in. x $2\frac{1}{2}$ in. in the centre. Between them, 24 barrier layer photocells 2 in. x $1\frac{1}{2}$ in. are arranged in a double layer facing outwards with a strip of rubber separating the two layers, and strips of copper foil making connection with the cells. The inner and outer edges of the sheets are then cemented together with strips of perspex and the whole made waterproof with a solution of perspex in chloroform. A pair of leads is fitted to allow connection to the photocells (which are all in parallel). In the central hole are placed three filament lamps (6 volts 12 watt). No lamp holders are used (for lack of space) the lamps being fixed in a wire frame with soldered electrical connections. Around the lamps is a metal strip, just wide enough to prevent any light reaching the photocells directly.

Provided the instrument is mounted so that there are no objects within about 50 ft. of it (except in its own plane) and there is no fog or mist, no light can reach the photocells from the lamps, and the current from the cells is very low (less than 0.2 microamp). If fog is present, however, light from the lamps is reflected by the fog particles and a current is generated by the photocells. This current should be roughly proportional to the scattering coefficient of the air, i.e. inversely proportional to the visibility.

3. Method of use

As stated above, it can only be used in darkness, and must be mounted well away from any other object, which implies, for best results, at least 50 ft. above the ground. Normally it is fixed at one edge to the flying cable of a tethered balloon, at least 20 ft. below the balloon.

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An accumulator to supply the lamps (6 amp. at 6 volts) must also be carried, though for restricted heights a transformer fed by a length of mains cable could possibly be used. In any case some means of switching the lamps on and off is needed, not only to reduce the drain on the battery, but to check any photocell current due to moonlight or artificial lights. If a remotely controlled switch presents difficulties, an automatic switch controlled by clockwork (or a heated bimetal system) can be used to switch the lamps on for, perhaps, five seconds every thirty seconds.

The galvanometer should have a full scale deflection of about 5 microamp. Its resistance (plus that of the cable to the photocells) should not exceed a few hundred ohms, and a mirror type is therefore necessary. The cable to the photocells can be fairly light, but must be very well insulated in view of the very small currents it carries, and the damp conditions in which it is used.

4. Results obtained

Tests at Cardington have confirmed the expectation that the photocell current would be inversely proportional to the visibility, the approximate relationship being:

Current x visibility = 300 microamp. yards.

For comparison, the following figures may be quoted:

Instrument in moonlight with lights off: current = 0.5 microamp.
Instrument in darkness, clear air, with lights on: current less than 0.2 microamp (but more if leads to lamps and cells are not kept carefully in the plane of the instrument).

Instrument 7 ft. from the ground with lights on: current = 3 microamp.

5. Conclusions

The instrument has been chiefly useful in finding the height of the base or top of a clearly defined layer of cloud or fog. It also gives a rough indication of the fog density, but its accuracy is likely to be limited by sampling errors, for most of the light reaching the photocells comes from the fog within one or two feet of them.

Its chief disadvantage is that it cannot be used in daylight. Other disadvantages which may restrict its use in some cases are: it cannot be used near the ground, or near other objects; its power requirements are rather large for a tethered balloon to carry; it needs rather a delicate galvanometer.

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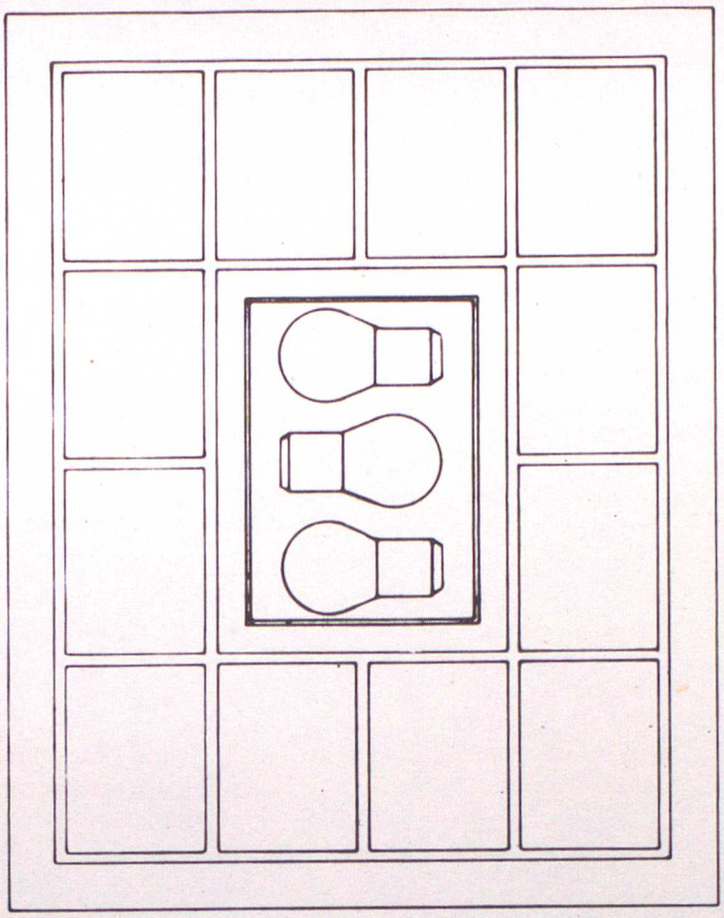

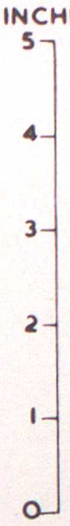
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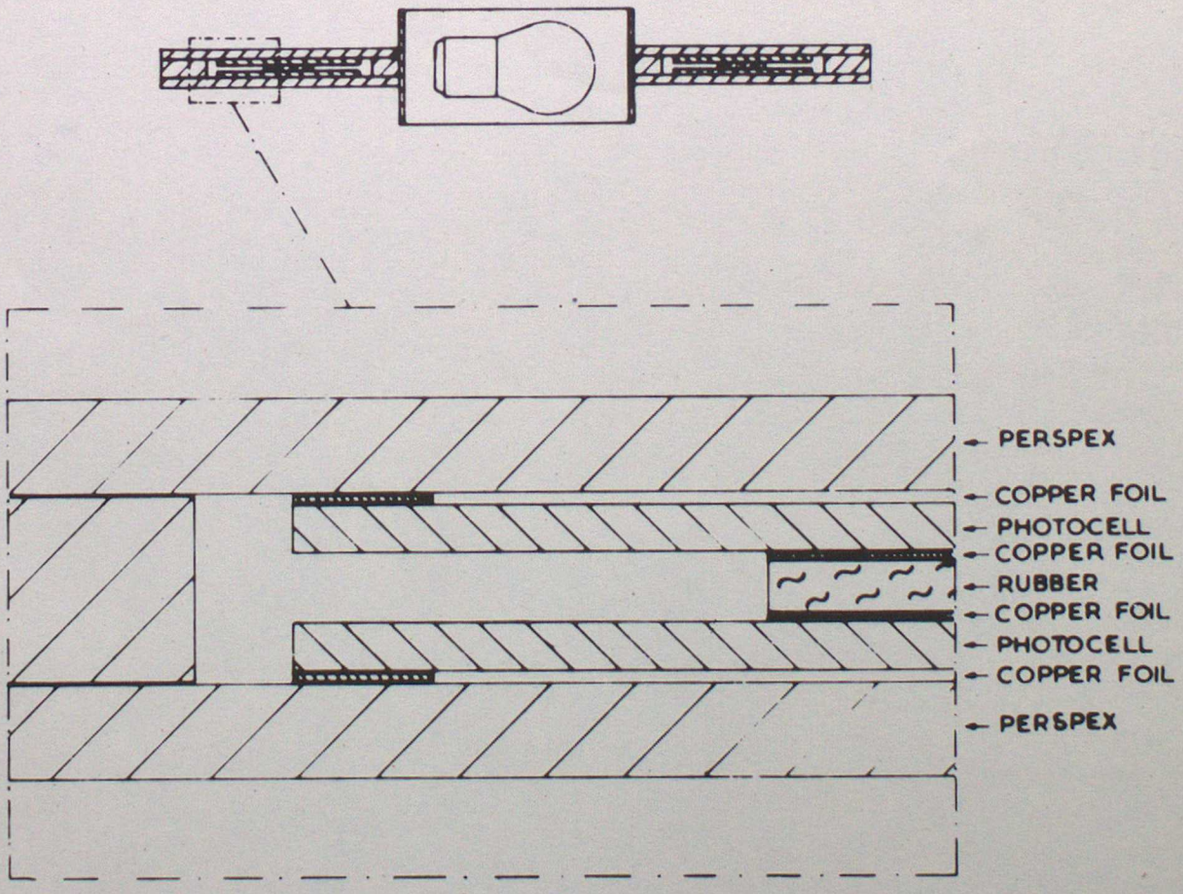
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FIG.1